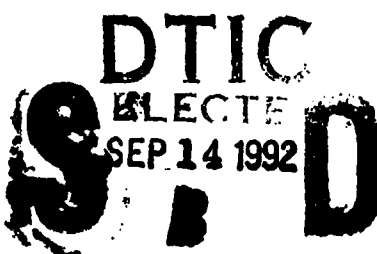


## REPORT DOCUMENTATION P

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|   |  |  |  |   |  |
|---|--|--|--|---|--|
| 1. AGENCY USE ONLY (Leave blank)  |  | 2. REPORT DATE<br>21 Oct. 91                               |  | 3. REPORT TYPE AND DATES COVERED<br>Preliminary   |  |
| 4. TITLE AND SUBTITLE<br>Preliminary Risk Assessment of the Remote Minehunting System (RMS)   |  |  |  | 5. FUNDING NUMBERS  |  |
| 6. AUTHOR(S)<br>COASTAL SYSYTEM STATION<br>PANAMA CITY, FL.   |  |  |  |   |  |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br>NSSC PMS407<br>Wash. D.C.<br>20362-5101   |  |  |  | 8. PERFORMING ORGANIZATION<br>REPORT NUMBER<br><br>N/A  |  |
| 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)<br><br>OPNAV 363  |  |  |  | 10. SPONSORING / MONITORING<br>AGENCY REPORT NUMBER<br><br>N/A  |  |
| 11. SUPPLEMENTARY NOTES<br><br>None   |  |  |  |   |  |
| 12a. DISTRIBUTION / AVAILABILITY STATEMENT<br><br>CLASSIFIED BY: [REDACTED]<br>DECLASSIFY ON: [REDACTED]  |  |  |  | 12b. DISTRIBUTION CODE<br><br>DISTRIBUTION STATEMENT A<br>Approved for public release<br>Distribution Unlimited |  |
| 13. ABSTRACT (Maximum 200 words)<br><br>This Risk Assesment of the RMS rates the risks associated with developing the sub-systems and components of the RMS. The risks are identified as low, medium, and high level so that high risk may be provided the highest resource priority. |  |  |  |   |  |
|   |  |  |  |   |  |
| 14. SUBJECT TERMS   |  |  |  | 15. NUMBER OF PAGES<br>31   |  |
|   |  |  |  | 16. PRICE CODE  |  |
| 17. SECURITY CLASSIFICATION<br>OF REPORT<br><br>UNCLASS   |  | 18. SECURITY CLASSIFICATION<br>OF THIS PAGE<br><br>Unclass |  | 19. SECURITY CLASSIFICATION<br>OF ABSTRACT<br><br>UNCLASS   |  |
|   |  |  |  | 20. LIMITATION OF ABSTRACT  |  |

**PRELIMINARY RISK ASSESSMENT  
OF THE  
REMOTE MINEHUNTING SYSTEM**

23 October 1991

**Prepared By:**

Naval Coastal Systems Center  
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**92-24765**



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## SECTION 1 INTRODUCTION

The objective of this Risk Assessment is to rate the risk associated with developing the subsystems and components of the Remote Minehunting System (RMS). The study identifies low, medium, and high risk levels so that high risk items can be assigned the highest resource priority.

In June 1989, the Chief of Naval Operations (CNO-374) released a Tentative Operational Requirement (TOR) to develop a remote minehunting capability. The Commander Naval Sea Systems Command (COMNAVSEASYS COM) (PMS-407) is the technical direction agent (TDA) to PMS-407. The Remote Minehunting System (RMS) will provide the surface fleet with a MCM capability organic to various task forces and craft of opportunity. The RMS may provide a capability to sustain a forward presence worldwide in operational areas, egress and exit lanes, and may assist in providing safe operational in economic, logistic shipping, and critical port locations. The RMS may further augment existing MCM forces. The TOR specifies the perceived threats, area search rates, and water depths along with certain system performance requirements. The RMS as currently perceived consists of a semisubmersible, remotely operated tow platform; a towed, variable depth sensor vehicle; and a data telemetry system.

A Work Breakdown Structure (WBS) of the RMS, created for this risk assessment, is presented in Section 2. The methodology used to assess the development subsystem and component risk is outlined in Section 3. The risk factors are discussed in Sections 4, 5, and 6 for the Sonar Vehicle (SV), the ROV Tow Platform, and the Host Vessel Control Station (CS) respectively. The risk associated with Integrated Logistics Support (ILS) items is discussed in Section 7. A summary listing of the resulting risk factors by risk category (high, medium, and low) is presented in Section 8. Diagrams of the WBS are included in Appendix A. The primary reference for this analysis is the Remote Minehunting System (RMS) Development Options Paper (DOP) (U) dated 21 June 1991; however, updated information on the RMS has been included in this assessment.

## SECTION 2 WORK BREAKDOWN STRUCTURE

A Work Breakdown Structure (WBS) was developed separate from the project WBS to structure the risk assessment for the three major systems: 1.0 Sensor Vehicle (SV), 2.0 ROV Tow Platform, and 3.0 Host Vessel/Control Station (CS). The WBS follows the format of the NAVSEA Expanded Ship Work Breakdown Structure (ESWBS) as much as possible down to the subsystem level. Numbers have been skipped to indicate that no significant equipment was identified for the RMS in that category. By skipping numbers rather than assigning the next consecutive number, the skipped ESWBS number was reserved for possible design changes. Third level numbers were assigned consecutively; however, where possible, the appropriate ESWBS number is identified for that particular equipment. The system level numbers that were skipped are identified in Table 1. Skipped third level ESWBS numbers are identified in the text where appropriate. Diagrams of the WBS for the risk assessment of the RMS are presented in Appendix A.

**TABLE 1. ESWBS CATEGORIES**

| <u>ESWBS<br/>No.</u> | <u>System Description</u> | <u>Sonar<br/>Vehicle</u> | <u>ROV Tow<br/>Platform</u> | <u>Host<br/>Vessel</u> |
|----------------------|---------------------------|--------------------------|-----------------------------|------------------------|
| 100                  | Hull Structure            | x                        | x                           | N/A                    |
| 200                  | Propulsion Plant          | none                     | x                           | N/A                    |
| 300                  | Electrical Plant          | x                        | x                           | x                      |
| 400                  | Command and Surveillance  | x                        | x                           | x                      |
| 500                  | Auxiliary Systems         | x                        | x                           | x                      |
| 600                  | Outfit and Furnishings    | none                     | x                           | x                      |
| 700                  | Armament                  | none                     | none                        | none                   |

An "x" indicates that there was equipment in that category, "none" indicates there was no equipment in that particular category, and "N/A" denotes that the category does not apply to the RMS. Items in the ESWBS 000 group (General Guidance and Administration) are discussed in Section 7. Assessment of the ESWBS 800 (Integration/Engineering) and 900 (Ship Assembly and Support Services) groups will be covered with the particular hardware.

### SECTION 3 RISK CRITERIA

The criteria used for this risk assessment are defined in this section. Development risk is assessed based on two qualitative factors: the potential for an item to fail development and the impact of a potential item development failure on the total program.

The potential for development failure is assumed to be proportional to the level of development required to make the item operational. Therefore, an off-the-shelf item requiring little or no development would have a low failure potential while a totally new development item would have a relatively high failure potential. The criteria for selecting factors for the level of development required are defined in Table 2. These factors reflect the relative maturity of the design of both the hardware and software, and have no relationship to the reliability of the item.

**TABLE 2. FAILURE POTENTIAL CRITERIA**

| FAILURE<br>POTENTIAL | DESIGN MATURITY/<br>DEVELOPMENT REQUIRED      |
|----------------------|---|
| None                 | Existing Item, Simple Design                  |
| Low                  | Minor Redesign, Minor Increase in Complexity  |
| Medium               | Major Change, Moderate Increase in Complexity |
| High                 | Never Done Before, Highly Complex             |

Failure impact reflects the consequences of a potential failure on the development program performance, cost, and schedule. The failure impact of an item which can be replaced by an alternate item with a slight performance degradation, small cost increase, and minimal program delay is defined as low level. Conversely, the failure impact of an item in development which would result in significantly degraded performance, higher cost, or major delays is defined as high level. The failure impact criteria are listed in Table 3.

The risk categories are defined as follows:

**Low Risk.** Risk is identifiable and would have minor effect or consequence on program objectives, but the potential for failure is sufficiently low to be no cause for concern.

**Medium Risk.** Risk is identifiable and failure of the item would affect program objectives, cost, or schedule.

**High Risk.** A high potential for failure to occur and the consequence would have a significant impact on the program.

The assignment of risk factors based on the failure potential and failure impact is diagrammed in Figure 1.

**TABLE 3. FAILURE IMPACT CRITERIA**

| FAILURE IMPACT | POSSIBLE CONSEQUENCES  |
|----------------|--|
| None           | Minimal or no consequences, unimportant. Program cost estimates not exceeded, some transfer of money. Negligible impact on program, slight development schedule change compensated by available slack. |
| Low            | Small reduction in technical performance. Program cost estimates exceed budget by 1 to 5 percent. Minor slip in schedule (less than 1 month), some adjustment in milestones required.                  |
| Medium         | Some reduction in technical performance. Program cost estimates increased by 5 to 20 percent. Development schedule slip between 1 and 3 months.  |
| High           | Major degradation in technical performance. Program cost estimates increased by 20 to 50 percent. Development schedule slip in excess of 3 months.   |
| Critical       | Technical goals cannot be achieved. Cost estimates increased in excess of 50 percent. Large schedule slip that affects segment milestones or has possible effect on system milestones.                 |

**Failure Impact**

|          |      |        |        |        |
|----------|------|--------|--------|--------|
| Critical | Low  | Medium | High   | High   |
| High     | Low  | Medium | Medium | High   |
| Medium   | Low  | Low    | Medium | Medium |
| Low      | Low  | Low    | Low    | Low    |
| None     | Low  | Low    | Low    | Low    |
|          | None | Low    | Medium | High   |

Failure Potential

**Figure 1. Assignment of Risk Factors**

## **SECTION 4 SONAR VEHICLE**

This section presents the failure potential, failure impact, and risk factors for subsystems, and components of the Sonar Vehicle (SV). The Sonar Vehicle includes the towfish hull, the sonars, and all other systems aboard the towfish. (The tether cable is defined to be part of the tow platform.) The closest system comparison is the Airborne MCM advanced minehunting sonar system, the AN/AQS-20. Compared to the RMS SV, the AQS-20 is about four feet shorter and has one less sonar system.

### **HULL STRUCTURE (WBS 1.100)**

There are two towfish items in the Hull Structure group (WBS 1.100): the pressure hull and the ballast system. The towfish pressure hull (WBS 1.110) includes the centerbody plates, longitudinal and transverse stiffeners, nose cone, and tail section. The ballast system (WBS 1.190) includes the solid ballast and the ballast release equipment aboard the SV. There were no items in the other ESWBS structure subgroups. The primary design issue is the arrangement of the sonars. Structure and stability designs should not require any new development.

### **PROPULSION PLANT (WBS 1.200)**

The current design for the sonar vehicle does not have propulsion. Therefore, propulsion (ESWBS 200) is omitted from further discussions on the current sonar vehicle design. However, a WBS number was reserved for future use should the vehicle be redesigned with self-propulsion.

### **ELECTRICAL POWER SYSTEM (WBS 1.300)**

The SV Electric Power System (ESWBS 300) has items in the Power Supply and Conversion (ESWBS 310) and Power Distribution (ESWBS 320) groups and none in the Lighting System (ESWBS 330) and Power Generation Support System (ESWBS 340) groups.

Power Supply and Conversion (WBS 1.310) - Power supplies and servicing equipment (ESWBS 313) and transformers (ESWBS 314). Further breakdown of this category was not necessary for the risk assessment. No major change from existing power supplies appears to be required at this time. The power requirements of a fourth sonar system, additional depth control, and navigation and vehicle sensors are an increase over the AQS-20 but should not require any significant development.

Power Distribution (WBS 1.320) - Interior cables, busses, and circuit breakers. No major change from conventional power cables, busses, circuit breakers, etc. appears to be required.

### **COMMAND, CONTROL, COMMUNICATIONS, AND NAVIGATION AND DETECTION (WBS 1.400)**

The SV Command, Control, Communications, and Navigation (C3N) and Detection System has items in the Navigation Sensors (ESWBS 420), Exterior Communication Systems (ESWBS 440), Detection Systems (ESWBS 460), and Special Purpose Systems (ESWBS 490) groups.

Navigation Sensors (WBS 1.420) - Acoustic transponder, depth control sensors, pitch/roll/heading gyros, and pitch/roll/yaw rate gyros. Although all are physically and functionally different, all appear to be off-the-shelf items. This resulted in identical probability and consequence factors of failure. Therefore, to simplify the presentation, the items were grouped together.

Exterior Communications (WBS 1.440) - Includes all items associated with the fiber optic data telemetry system except the hull penetration, towpoint and release mechanism. The data from the fourth sonar is a moderate increase over AQS-20 external communication requirements.

Detection Sensors and Processing (WBS 1.460) All detection sensors identified for the SV are active sonars (ESWBS 461) and would be numbered 1.461 if the ESWBS categories were strictly followed. To minimize the number of levels it was decided to eliminate the option of other detection systems in the ESWBS and assign the next digit to identify the type of active sonar, i.e., the Volume Search Sonar is 1.461 rather than 1.4611.

Volume Search Sonar (WBS 1.461) The components of the Volume Search Sonar (VSS) are being developed under the Mine and Special Warfare 6.2 Program Element. This is a new development item that is the first of its kind; therefore, it the VSS was rated as having a high failure potential. Further, since there appears to be no suitable alternative which does not result in either a major performance degradation or a major schedule delay/cost increase, the failure impact was also rated as high. It was considered high rather than critical since it was felt that the VSS is a feasible concept and that any development failure could be overcome eventually.

Side Looking Sonar (SLS) (WBS 1.462) Like the VSS, the Side Looking Sonar (SLS) is in 6.2 development. In comparison with to the high failure potential assessed the VSS, the successful development of a lower performance side looking sonar for the AQS-20 lowered the failure potential. However, it was felt that the performance of this system, if selected as a replacement for the SLS, would be a significant reduction in performance to justify a high level failure impact.

Gap Filling Sonar (GFS) (WBS 1.463) The GFS is an off the shelf item. The R&D effort will be to integrate the GFS output with data from the other three sonars.

Ahead Looking Sonar (ALS) (WBS 1.464) Like the GFS, the ALS is an off the shelf item. The R&D effort will be to integrate the ALS output with data from the other three sonars.

Vehicle Sensors and Processing (WBS 1.490) This category includes sonar vehicle sensors not in the navigation system (WBS 1.420) or the detection system (WBS 1.460). Specific sensors include the state sensors and the sound velocimeter. Like the navigation sensors, because of their identical risk characteristics, these sensors were combined into one WBS group. Based on the DOP, these sensors will be state-of-the-art, off-the-shelf items.

## **AUXILIARY SYSTEMS (WBS 1.500)**

Depth Control System (WBS 1.560) Depth control is in the Steering and Diving Controls group (ESWBS 561) of Ship Control Systems (ESWBS 560). This includes all hardware and software controlling the motion and location of the towfish. It does not includes navigation and telemetry items. It is expected that the depth control system will be a minor redesign of systems either in use or possibly in advanced development.

## OUTFIT AND FURNISHINGS (WBS 1.600)

Towpoint and Release (WBS 1.610) The mechanical towpoint and emergency release device on the towed body is in the Fittings group (ESWBS 610). It is expected that the towpoint and release system will be a minor redesign of AMCM systems in use.

Paint, Insulation, and Damping (WBS 1.630) The Preservatives and Coating Section (ESWBS 630) includes separate categories for paint (ESWBS 631), hull insulation (ESWBS 635), and hull damping (ESWBS 636). These items will be critical to ensure that self-generated noise (including flow noise): 1) does not degrade the performance of the ownship sonars and 2) does not provide a detectable signature to the mines. Because of the possibility of encountering multiple influence mines, both acoustic and magnetic signatures must be considered.

**TABLE 4. SUMMARY OF SONAR VEHICLE RISK**

| WBS   | Item Description               | Failure Potential | Failure Impact | Factor Risk |
|-------|--------------------------------|-------------------|----------------|-------------|
| 1.110 | Pressure Hull                  | Low               | Low            | Low         |
| 1.190 | Ballast System                 | Low               | Low            | Low         |
| 1.310 | Power Supply and Conversion    | Low               | Low            | Low         |
| 1.320 | Power Distribution             | Low               | Low            | Low         |
| 1.420 | Navigation Sensors             | None              | Low            | Low         |
| 1.440 | Exterior Communications        | Low               | Low            | Low         |
| 1.461 | Volume Search Sonar            | High              | High           | High        |
| 1.462 | Side Looking Sonar             | Medium            | High           | Medium      |
| 1.463 | Gap Filling Sonar              | None              | Low            | Low         |
| 1.464 | Ahead Looking Sonar            | None              | Low            | Low         |
| 1.490 | Vehicle Sensors & Processing   | None              | Low            | Low         |
| 1.560 | Depth Control System           | Low               | Low            | Low         |
| 1.610 | Towpoint and Release           | None              | Low            | Low         |
| 1.630 | Paint, Insulation, and Damping | None              | Low            | Low         |

## SECTION 5 REMOTELY OPERATED VEHICLE TOW PLATFORM

This section discusses failure potential, failure impact, and the risk factors for the subsystems, and components of the Remotely Operated Vehicle (ROV) Tow Platform. The DOP identifies the tow platform as a remote operated, semisubmerged vehicle significantly more complex than the Canadian-built Dolphin ROV.

### HULL STRUCTURE (WBS 2.100)

The ROV Hull Structure includes the following items: Pressure Hull (ESWBS 110 - Shell and Supporting Structure), Superstructure and Fairwater (ESWBS 151 under ESWBS 150 - Deck House Structure), Stack and Mast (ESWBS 162 under ESWBS 160 - Special Structures), Foundations (ESWBS 180), and three Special Purpose Systems (ESWBS 190). There were no items in the following ESWBS groups: Bulkheads (120), Hull Decks (130), and Masts, Kingposts, and Service Platforms (170).

Although the complexity increase over the Dolphin is significant, it is felt that there is the potential for development failure should be low because of the state-of-the-art design methods used. However, because of the potentially high cost and schedule consequences if a development failure occurs, the failure impact was rated as high level.

Pressure Hull (WBS 2.110) The Pressure Hull group includes hull plating and support structure (i.e., longitudinal and transverse strength members), the nose cone, and tail sections.

Superstructure and Fairwater (WBS 2.150) Although the proposed ROV has no conventional superstructure, it does have a significant structure beneath the pressure hull to house the tow body handling system. It was decided to categorize this structure as an ESWBS 150 item. This structure must enclose the tow system with minimum drag increase.

Stack and Mast (WBS 2.160) The Stack and Mast group includes the structure for the RF mast and the diesel snorkel. This category refers only to the structural design not the success of the antenna, the intake air, or the hydrodynamics. The larger engine will require more intake air, hence larger, than the Dolphin snorkel.

Machinery Foundations (WBS 2.180) Machinery foundations, i.e., engine foundations, will be a critical point in the structural design. Damping the vibrations is critical not just for structural load criteria but also for acoustic signature minimization. The larger engine combined with the sensitivity of mines may require a change in foundation design over existing ROVs to minimize acoustic signature.

Special Purpose Structures (WBS 2.190) The ROV's Ballast and Buoyancy (WBS 2.191) and Free Flooding Compartments (WBS 2.192) are classified as Special Purpose Structures (ESWBS 190). The Ballast and Buoyancy Group includes the solid material used for ballast and buoyancy, and the ballast release mechanism. Although the quantity of ballast and buoyancy may be more than that on existing ROVs, it is felt that minor changes to the design of existing systems should accomplish the task.

### PROPULSION SYSTEMS (WBS 2.200)

The Propulsion Systems group for the ROV includes the engine and engine control (Energy Generating Systems (Non-Nuclear) group - ESWBS 230); transmission system; i.e.,

gear boxes, shafts, bearings, and propeller) (Transmission and Propulsion Systems - ESWBS 240), intake/exhaust air (Propulsion Support Systems - ESWBS 250); and fuel and lube oil systems (Propulsion Support Systems (Fuel and Lube Oil) - ESWBS 260).

Diesel Engine and Engine Controls (WBS 2.230) The diesel engine and its controls are in the ESWBS 233 subgroup. Several existing marine diesel engines are available for use; however, each requires a different transmission. Therefore, a medium level failure impact was assessed to account for a development failure due to the engine that would necessitate changing transmission designs.

Transmission and Propulsion Systems (WBS 2.240) For the ROV, the Transmission and Propulsion Systems group (ESWBS 240) includes all items in the Propulsion Reduction Gears (ESWBS 241), Clutches and Couplings (ESWBS 242), Shafting (ESWBS 243), Bearings (ESWBS 244) and Propulsors (ESWBS 245) subgroups. There are no items in the Shrouds and Ducts (ESWBS 246), Water Jets (ESWBS 247), and Lift Systems (ESWBS 248) subgroups.

Intake and Exhaust Air Systems (WBS 2.250) The Intake and Exhaust Air Systems consists of items in the Combustion Air Systems (ESWBS 251) subgroup.

Fuel and Lube Oil Systems (WBS 2.260) For this analysis, this subgroup combines items normally in ESWBS 250 - Propulsion Support Systems (Fuel and Lube Oil) and those in ESWBS 540 - Fuels and Lube Oils, Handling and Storage.

## **ELECTRIC POWER SYSTEMS (WBS 2.300)**

Items in the ROV's Electric Power System are in the ESWBS 200 - Electric Plant group. These items are in two categories - Power Generation (ESWBS 310) and Power Distribution (ESWBS 320). There are no items in the Lighting (ESWBS 330) and Power Generation Support (ESWBS 340) subgroups.

Power Generation (WBS 2.310) Power Generation includes the Service Generator (WBS 2.311), Emergency Power System (WBS 2.312), Batteries and Servicing System (WBS 2.313), and the Power Conversion System (WBS 2.314).

Power Distribution (WBS 2.320) Power Distribution includes all the cables, busses, and circuit breakers in the ROV and the power cable to the towed vehicle.

## **C3N AND DETECTION SYSTEMS (WBS 2.400)**

For the ROV Tow Platform, the C3N and Detection System Group consists of items in the Command and Surveillance Systems group (ESWBS 400). This includes items in the Navigation Systems (ESWBS 420), Exterior Communication System (ESWBS 440), Detection Systems (ESWBS 460), and Special Purpose Systems (ESWBS 490) subgroups. Sonar data acquisition and processing is the only detection system item while the vehicle sensors and processing is the only special purpose system.

### Navigation System (WBS 2.420)

Exterior Communication Systems (WBS 2.440) The ROV has two exterior communication systems, an RF link to the control station and a fiber optic link with the towed body. Although the physical characteristic of the two systems are quite different, the risk parameters turned out to be very similar; therefore, only one set of values is presented for the two systems.

*Insulation*  
Sonar Data Processing (WBS 2.460) The proposed concept includes processing of sonar data aboard the ROV to minimize RF data telemetry requirements.

Vehicle Sensors and Processing (WBS 2.490) This subgroup includes all sensors aboard the ROV except those used for navigation and control, i.e., vehicle status sensors. These are expected to be off the shelf items. Therefore, it is assumed that the next best available sensors would result in either a small reduction in technical performance or a small cost increase.

## **AUXILIARY SYSTEMS (WBS 2.500)**

The ROV Auxiliary Systems group (ESWBS 500) includes items in the Climate Control (ESWBS 510), Ship Control Systems (ESWBS 560), and Special Purpose Systems (ESWBS 590) subgroups. The one Special Purpose System is the Underwater Body Tow, Launch, and Handling System (ESWBS 595). No items were identified in any of the other subgroups under ESWBS 500.

Climate Control Equipment (WBS 2.510) The primary problem will be preventing heat problems resulting from the large horsepower diesel engine.

Ship Control System (WBS 2.560) The ROV Ship Control System group includes items in the Steering and Depth Control System (ESWBS 561), Rudder (ESWBS 562), Hovering and Depth Control (ESWBS 563), Trim Control (ESWBS 564), and the Diving Planes and Stabilizing Fins (ESWBS 566) subgroups. For this risk assessment, items from those five subgroups were assessed together. If the design of the ship control system failed, it was assumed that an alternative with lower performance could be developed and implemented, at an additional cost and with some delay.

Underwater Body Tow, Launch, and Handling System (WBS 2.590) Similar systems have been developed for vehicles used for diving, salvage, and underwater construction. The primary development issue appears to be accommodating the system within the hull space available.

Paint, Insulation, and Damping (WBS 2.630) The Preservatives and Coating Section (ESWBS 630) includes paint (ESWBS 631), hull insulation (ESWBS 635), and hull damping (ESWBS 636). These items will be critical to ensure that self-generated noise does not provide a detectable signature to the mines. Because of the possibility of encountering multiple influence mines, both acoustic and magnetic signatures must be considered.

**TABLE 5. SUMMARY OF ROV TOW PLATFORM RISK**

| WBS   | Item Description                                 | Failure Potential | Failure Impact | Factor Risk |
|-------|--|-------------------|----------------|-------------|
| 2.100 | Hull Structure                                   | Low               | High           | Medium      |
| 2.110 | Pressure Hull                                    | Low               |                |             |
| 2.150 | Superstructure and Fairwater                     | Low               |                |             |
| 2.160 | Stack and Mast                                   | Low               |                |             |
| 2.180 | Machinery Foundations                            | Low               |                |             |
| 2.190 | Special Purpose Structures                       | Low               |                |             |
| 2.191 | Ballast and Buoyancy                             | Low               |                |             |
| 2.192 | Free Flooding Compartments                       | Low               |                |             |
| 2.200 | Propulsion System                                |                   |                |             |
| 2.230 | Diesel Engine and Controls                       | Low               | Medium         | Low         |
| 2.240 | Transmission and Propeller                       | Low               | Low            | Low         |
| 2.250 | Intake & Exhaust Air Systems                     | Low               | Low            | Low         |
| 2.260 | Fuel and Lube Oil Systems                        | Low               | Low            | Low         |
| 2.300 | Electric Power System                            |                   |                |             |
| 2.310 | Power Generation System                          | Low               | Low            | Low         |
| 2.311 | Service Generator                                | None              | Low            | Low         |
| 2.312 | Emergency System                                 | Low               | Low            | Low         |
| 2.313 | Batteries and Servicing                          | Low               | Low            | Low         |
| 2.314 | Transformer(s)                                   | None              | Low            | Low         |
| 2.320 | Power Distribution System                        | Low               | Low            | Low         |
| 2.400 | C3N and Detection System                         |                   |                |             |
| 2.420 | Navigation System                                | Low               | Low            | Low         |
| 2.440 | Exterior Communications                          | Medium            | Medium         | Medium      |
| 2.460 | Sonar Data Processing                            | Medium            | Low            | Low         |
| 2.490 | Vehicle Sensors & Processing                     | None              | Low            | Low         |
| 2.500 | Auxiliary Systems                                |                   |                |             |
| 2.510 | Climate Control Equipment                        | Low               | Low            | Low         |
| 2.560 | Ship Control System                              | Medium            | Low            | Low         |
| 2.590 | Underwater Body Tow, Launch, and Handling System | Low               | Medium         | Low         |

## SECTION 6 HOST VESSEL/CONTROL STATION

This section discusses the systems, subsystems, and components of the Host Vessel/Control Station (CS). The Host Vessel/Control Station System consists of all items aboard the host vessel during employment of the system. These include items in the Electric Power System (ESWBS 300), C3N and Detection System (ESWBS 400), Auxiliary System (ESWBS 500), and Outfit and Furnishings (ESWBS 600) groups, but none in the Hull Structure (ESWBS 100) and Propulsion (ESWBS 200) groups.

### ELECTRICAL POWER SYSTEM (WBS 3.300)

Items in the Host Vessel/Control Station Electric Power System are in the ESWBS 200 - Electric Plant group. These items are in two categories - Power Generation (ESWBS 310) and Power Distribution (ESWBS 320). There were no significant items in the Lighting (ESWBS 330) and Power Generation Support (ESWBS 340) subgroups.

Power Generation System (WBS 3.310) Off-the-shelf generator and transformer(s).

Power Distribution (WBS 3.320) Off-the-shelf cables, busses, and circuit breakers.

### C3N AND DETECTION SYSTEMS (WBS 3.400)

Items are in the Command and Control (ESWBS 410), the Navigation Control (ESWBS 420), Interior Communications (ESWBS 430), Exterior Communications (ESWBS 440), and Active Sonar (ESWBS 461) subgroups.

Mission Console (WBS 3.410) The primary item in the Command and Control subgroup is the mission console. The mission console has two components, the tactical display (WBS 3.411) and the environmental display (WBS 3.412). Tactical displays from existing SMCM systems should be adaptable to the RMS with minor redesign. It was assumed that another tactical display could be found. Environmental displays from existing SMCM systems should be adaptable to the RMS with minor redesign.

Navigation System (WBS 3.420) The RMS navigation system components aboard the host vessel consist of the ROV navigation monitoring console (WBS 3.421) and the GPS link (WBS 3.422). Depending on the operations area, switching from GPS may degrade performance.

Interior Communications (WBS 3.430) There are two items in the interior communications subgroup: Bridge and Deck Radio Communications (WBS 3.431), and Deck TV Controls (WBS 3.432).

Exterior Communications (WBS 3.440) Exterior Communication Systems include Battle Group Commander Radio Communications (WBS 3.441) and Telemetry Communications (with ROV) (WBS 3.442). Success of the development depends on sonar telemetry experience. The alternative to telemetering less raw sonar data, i.e., process more aboard either the sonar vehicle or the tow platform.

Detection System (WBS 3.460) Detection system components aboard the host vessel include a sonar controller, a sonar display, and a sonar data plotting and recording system.

Sonar Controller (WBS 3.461) No apparent alternative to developing a controller for the four sonars. Inability to control the four sonars would be a significant degradation of performance.

Sonar Display (WBS 3.462) Alternative is to use conventional displays and plotters.

Sonar Data Plotting and Recording (WBS 3.463) - Alternative plotters and recorders should be available either slightly lower performance, increased weight, or higher cost.

#### **AUXILIARY SYSTEMS (WBS 3.500)**

The RMS systems aboard the host vessel that are in the Auxiliary Systems group (WBS 3.560) are: 1) Control Station HVAC (WBS 3.510), 2) ROV Ship Control System (WBS 3.560), and 3) the ROV/SV Handling and Stowage System (ESWBS 580 - Mechanical Handling Systems). All Control Station heating, ventilation, and air conditioning (HVAC) was assumed to be off-the-shelf items.

#### **OUTFIT AND FURNISHINGS (WBS 3.600)**

For the Host Vessel, there is one item in the Outfit and Furnishings group (ESWBS 600) - the work and stowage space MILVAN. The control station (ESWBS 663), maintenance area (ESWBS 665), and spares stowage space (ESWBS 670) will be in the same MILVAN. The work space item was designated WBS 3.660 and includes the control station, maintenance area, and spares stowage in the MILVAN.

**TABLE 6. SUMMARY OF HOST VESSEL/CONTROL STATION RISK**

| WBS   | Item Description            | Failure Potential | Failure Impact | Factor Risk |
|-------|-----------------------------|-------------------|----------------|-------------|
| 3.300 | Electric Power System       | None              | Low            | Low         |
| 3.310 | Power Generation            | None              | Low            | Low         |
| 3.320 | Power Distribution          | None              | Low            | Low         |
| 3.400 | C3N and Detection           |                   |                |             |
| 3.410 | Mission Console             | Low               | Low            | Low         |
| 3.411 | Tactical Display            | Low               | Low            | Low         |
| 3.412 | Environmental Display       | Low               | Low            | Low         |
| 3.420 | Navigation System           |                   |                |             |
| 3.421 | ROV Navigation Console      | Low               | Low            | Low         |
| 3.422 | GPS Link                    | Low               | Medium         | Low         |
| 3.430 | Interior Communication      |                   |                |             |
| 3.431 | Bridge and Deck Radios      | None              | Low            | Low         |
| 3.432 | Deck TV Controls            | None              | Low            | Low         |
| 3.440 | Exterior Communications     |                   |                |             |
| 3.441 | Battle Group Cmdr Radio     | None              | Low            | Low         |
| 3.442 | RF Telemetry Comms (w/ ROV) | Medium            | Low            | Low         |
| 3.460 | Detection System            |                   |                |             |
| 3.461 | Sonar Controller            | Medium            | Medium         | Medium      |
| 3.462 | Sonar Display               | Low               | Low            | Low         |
| 3.463 | Sonar Data Plotter & Recdr  | Low               | Low            | Low         |
| 3.500 | Auxiliary Systems           |                   |                |             |
| 3.510 | Control Van HVAC            | Low               | Low            | Low         |
| 3.560 | ROV Control Console         | Low               | Low            | Low         |
| 3.580 | ROV/SV Handling & Stowage   | Low               | Low            | Low         |
| 3.600 | Outfit and Furnishing       |                   |                |             |
| 3.660 | Work Space                  | Low               | Low            | Low         |

## **SECTION 7 INTEGRATED LOGISTICS SUPPORT**

The General Guidance and Administration group (ESWBS 000) includes a wide variety of technical studies and requirements such as combat capabilities, performance, and design and construction standards. The risk assessment of most of the ESWBS 000 items is inherent in the risk assessment of the corresponding hardware. For example, drag and powering of the tow platform is treated in the propulsion system group. However, one subgroup, Integrated Logistics Support (ILS) Requirements (ESWBS 080) applies to all hardware. Therefore, it was decided to address risk assessment for total system, i.e., SV/ROV/CS combined. Rather than using the criteria outlined in the previous section, each ESWBS ILS item will be rated qualitatively as either low, medium, or high risk.

### **HIGH RISK ILS ITEMS**

No ILS issues were identified as high risk.

### **MEDIUM RISK ILS ITEMS**

Maintenance (ESWBS 081). Because of the large number of high technology components of the ROV and the SV, preventive maintenance should be more extensive than existing Surface MCM and Airborne MCM systems. Also, corrective maintenance may be difficult because of potential handling problems with the ROV and SV when deployed in an operational situation.

### **LOW RISK ILS ITEMS**

At this time, RMS ILS items in the following ESWBS subgroups appear to be low risk:

- Supply Support (ESWBS 083)
- Transportation and Handling (ESWBS 084)
- Engineering Drawings (ESWBS 085)
- Technical Manuals (ESWBS 086)
- Facilities (ESWBS 087)
- Personnel and Training (ESWBS 088)
- Training Equipment (ESWBS 089)

## SECTION 8 SUMMARY

This section summarizes the risk assessments by listing the items from the three major subsystems (SV, ROV, and CS) in each of the three risk categories.

### HIGH RISK ITEMS

In the preceding section, the development of the components and subsystems listed in Table 7 was rated to be a high risk. Based on the lack of design maturity it was judged that each item has a high potential for failure and the consequence would have a significant impact on the program.

TABLE 7. SUMMARY OF HIGH RISK ITEMS

| System | Item                       | Failure Potential | Failure Impact |
|--------|----------------------------|-------------------|----------------|
| SV     | Volume Search Sonar System | High              | High           |

### MEDIUM RISK ITEMS

The development of each of the components and subsystems listed in Table 8 was rated as a medium risk. For these components and subsystems risk is identifiable and its occurrence would affect program objectives, cost, or schedule.

TABLE 8. SUMMARY OF MEDIUM RISK ITEMS

| System | Item                          | Failure Potential | Failure Impact |
|--------|-------------------------------|-------------------|----------------|
| SV     | Side Looking Sonar            | Medium            | High           |
| ROV    | Exterior Communications       | Medium            | Medium         |
| CS     | Sonar Controller              | Medium            | Medium         |
| ROV    | Hull Structure and Appendages | Low               | High           |

### LOW RISK ITEMS

The development of each of the components and subsystems listed in Table 9 was rated as a low risk. For each of these items, risk is identifiable and would have minor effect or consequence on program objectives, but the probability of occurrence is sufficiently low as to cause no concern.

**TABLE 9. SUMMARY OF LOW RISK ITEMS**

| System | Item                           | Failure Potential | Failure Impact |
|--------|--------------------------------|-------------------|----------------|
| SV     | Towfish Pressure Hull          | Low               | Low            |
|        | Ballast System                 | Low               | Low            |
|        | Power Supply and Conversion    | Low               | Low            |
|        | Power Distribution System      | Low               | Low            |
|        | Navigation Sensors             | None              | Low            |
|        | Exterior Communications        | Low               | Low            |
|        | Gap Filling Sonar (GFS)        | None              | Low            |
|        | Ahead Looking Sonar (ALS)      | None              | Low            |
|        | Vehicle Sensors & Processing   | None              | Low            |
|        | Depth Control System           | Low               | Low            |
|        | Towpoint and Release           | None              | Low            |
|        | Paint, Insulation, and Damping | None              | Low            |
| ROV    | Diesel Engine and Controls     | None              | Medium         |
|        | Transmission and Propeller     | Low               | Low            |
|        | Intake & Exhaust Air Systems   | Low               | Low            |
|        | Fuel and Lube Oil Systems      | Low               | Low            |
|        | Power Generation System        | Low               | Low            |
|        | Service Generator              | None              | Low            |
|        | Emergency System               | Low               | Low            |
|        | Batteries and Servicing        | Low               | Low            |
|        | Transformer(s)                 | None              | Low            |
|        | Power Distribution System      | Low               | Low            |
|        | Navigation System              | Low               | Low            |
|        | Sonar Data Processing          | Medium            | Low            |
|        | Vehicle Sensors & Processing   | None              | Low            |
|        | Climate Control Equipment      | Low               | Low            |
|        | Ship Control System            | Medium            | Low            |
|        | Underwater Body Tow System     | Low               | Medium         |
| CS     | Electric Power System          | None              | Low            |
|        | Power Generation               | None              | Low            |
|        | Power Distribution             | None              | Low            |
|        | Mission Console                | Low               | Low            |
|        | Tactical Display               | Low               | Low            |
|        | Environmental Display          | Low               | Low            |
|        | ROV Navigation Console         | Low               | Low            |
|        | GPS Link                       | Low               | Medium         |
|        | Bridge and Deck Radios         | None              | Low            |
|        | Deck TV Controls               | None              | Low            |
|        | Battle Group Cmdr Radio        | None              | Low            |
|        | RF Telemetry Comms (w/ ROV)    | Medium            | Low            |
|        | Sonar Display                  | Low               | Low            |
|        | Sonar Data Plotter & Recrdr    | Low               | Low            |
|        | Control Van HVAC               | Low               | Low            |
|        | ROV Control Console            | Low               | Low            |
|        | ROV/SV Handling & Stowage      | Low               | Low            |
|        | Work Space                     | Low               | Low            |

**APPENDIX A**

**WORK BREAKDOWN STRUCTURE DIAGRAMS**

The Work Breakdown Structure (WBS) for the risk assessment of the RMS is presented in Figures A-1 through A-8. This WBS was developed separate from the project WBS to structure the risk assessment and covers the three major systems: 1.0 Sensor Vehicle (SV), 2.0 ROV Tow Platform, and 3.0 Host Vessel/Control Station (CS).

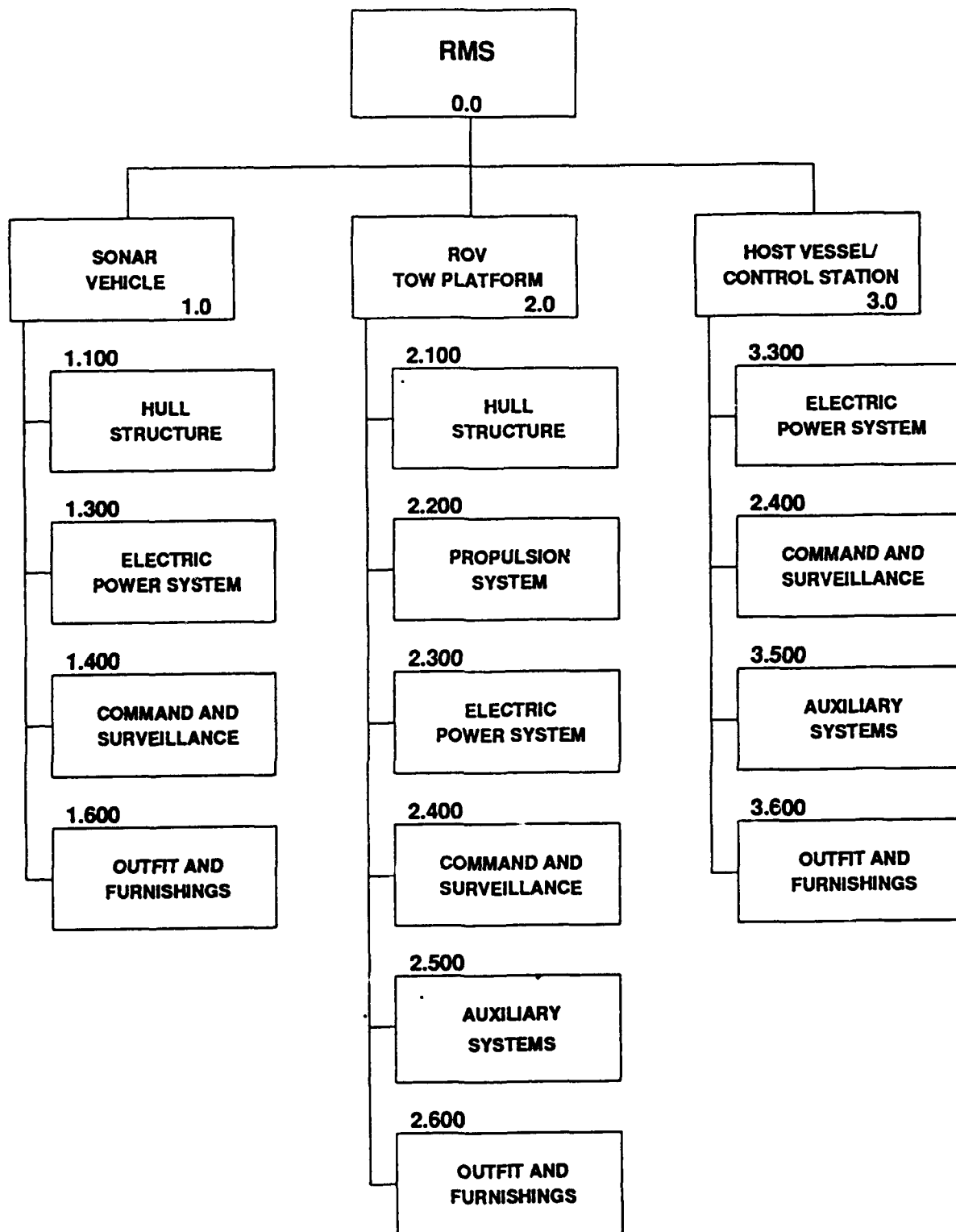
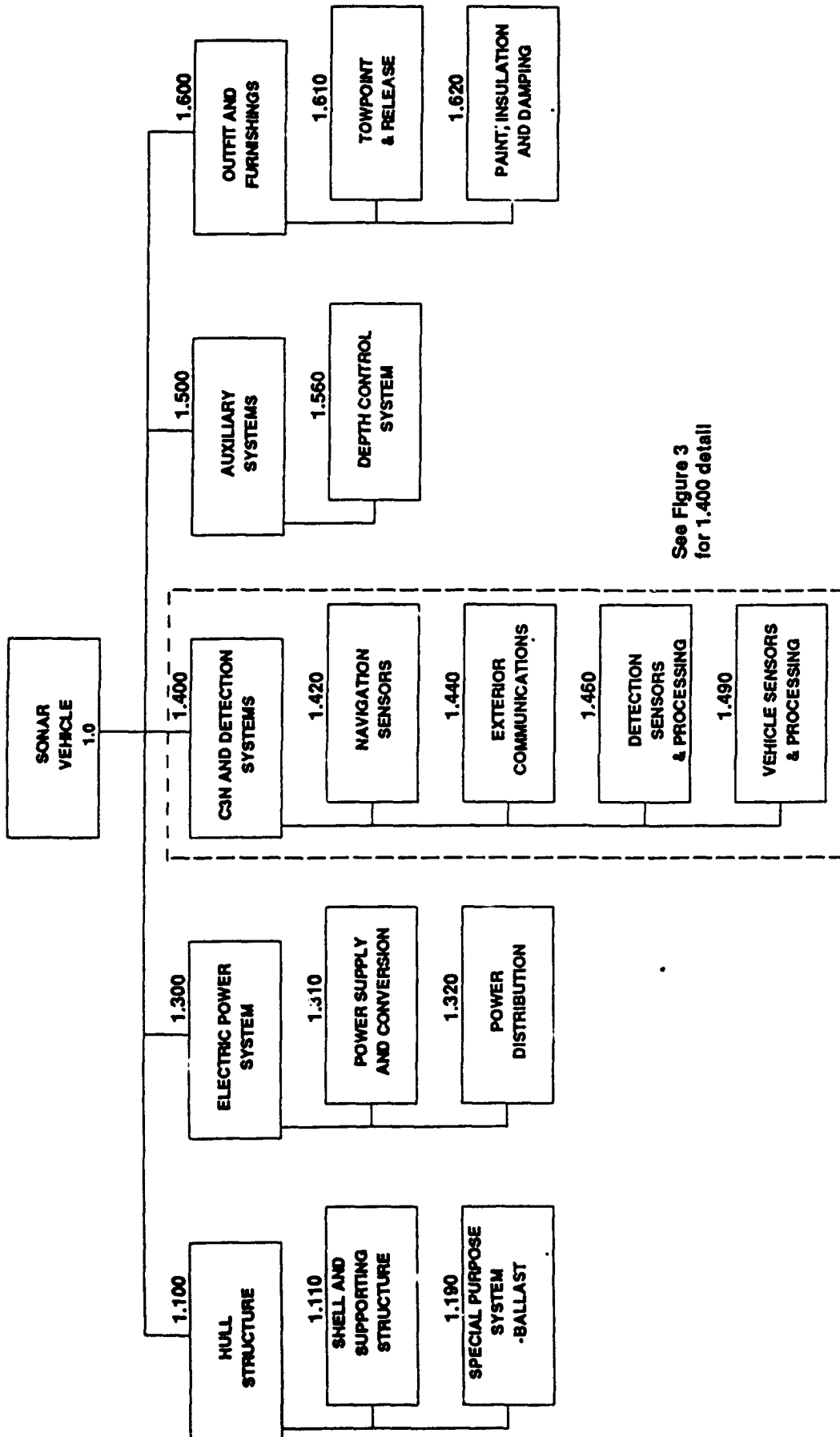


Figure 1. RMS Risk Assessment WBS



See Figure 3  
for 1.400 detail

Figure 2. Sonar Vehicle Risk Assessment WBS

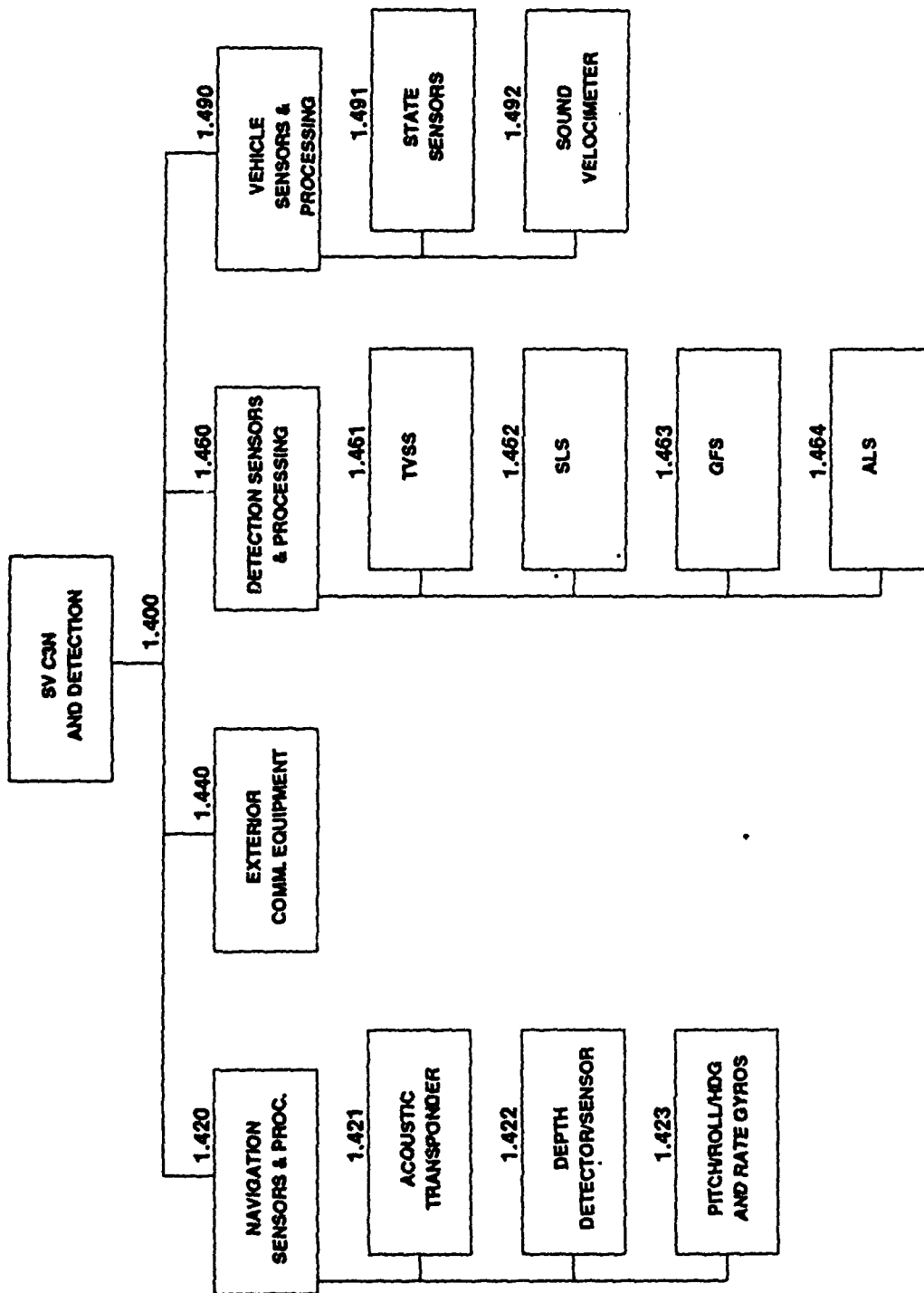
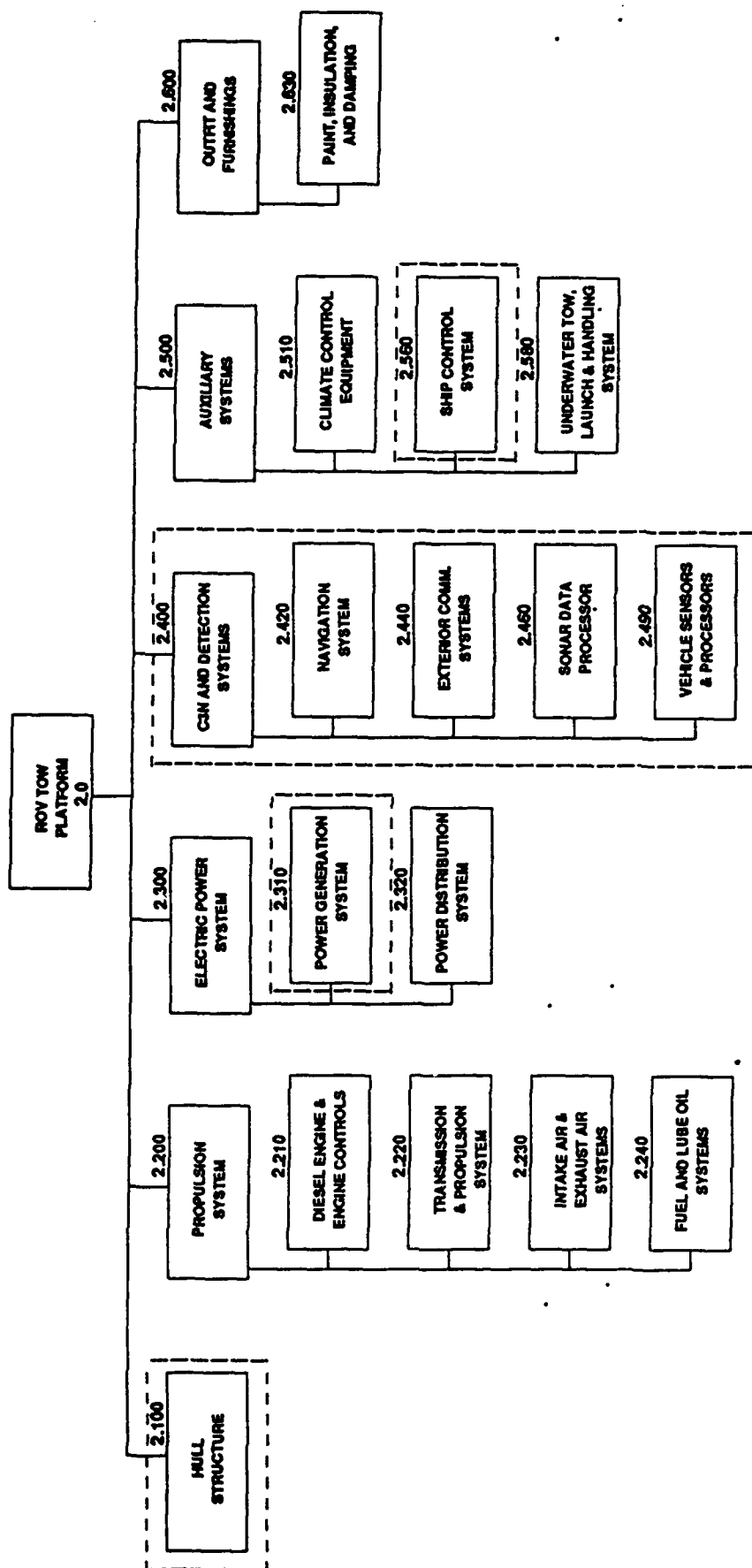


Figure 3. Sonar Vehicle C3N and Detection Risk Assessment WBS



2.100, 2.310, and 2.560 are shown in detail in Figure 5  
 2.400 is shown in detail in Figure 6

Figure 4. ROV Tow Platform Risk Assessment WBS

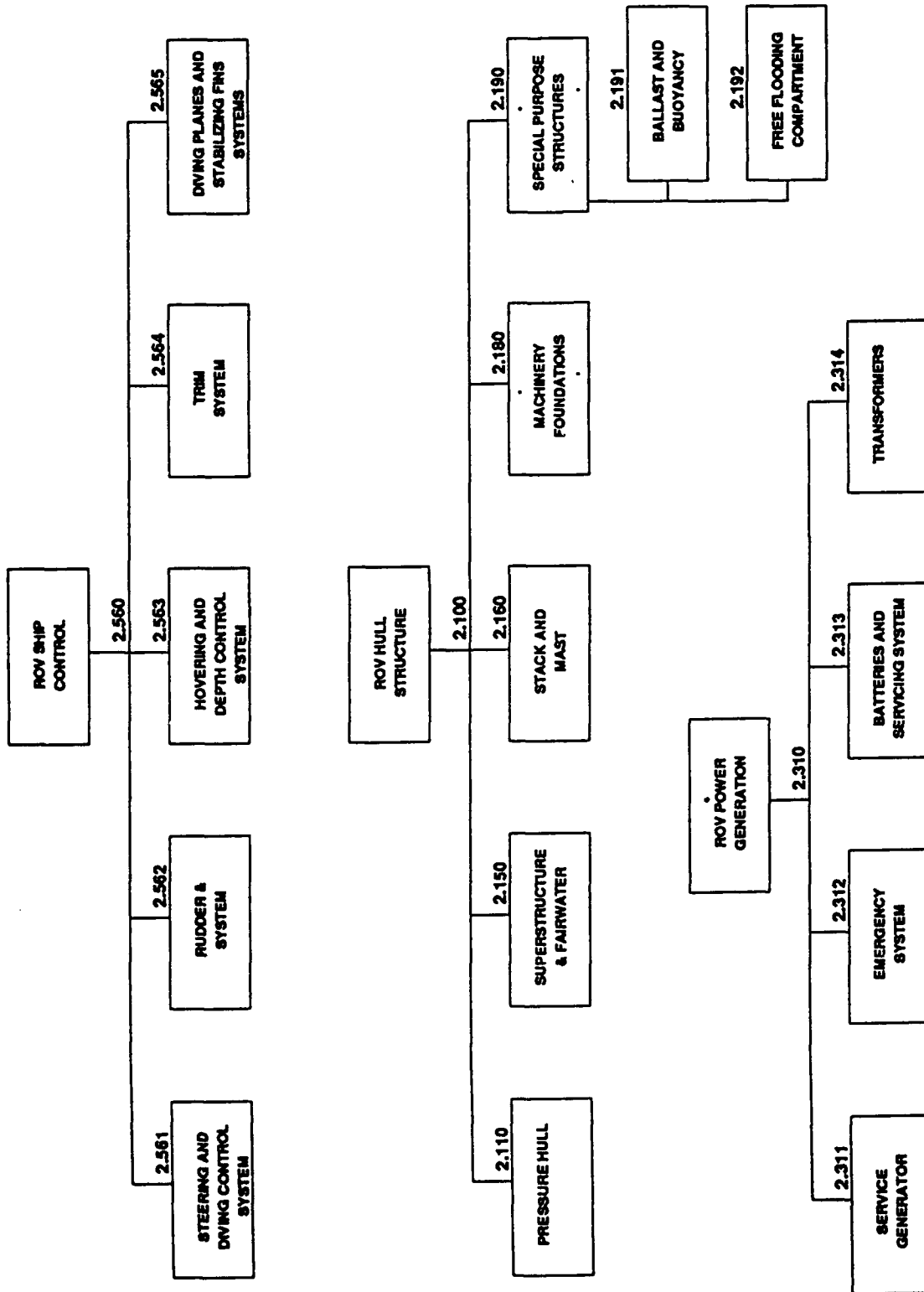


Figure 5. ROV Structure, Power Generation, and Ship Control Subsystems Risk Assessment WBS's

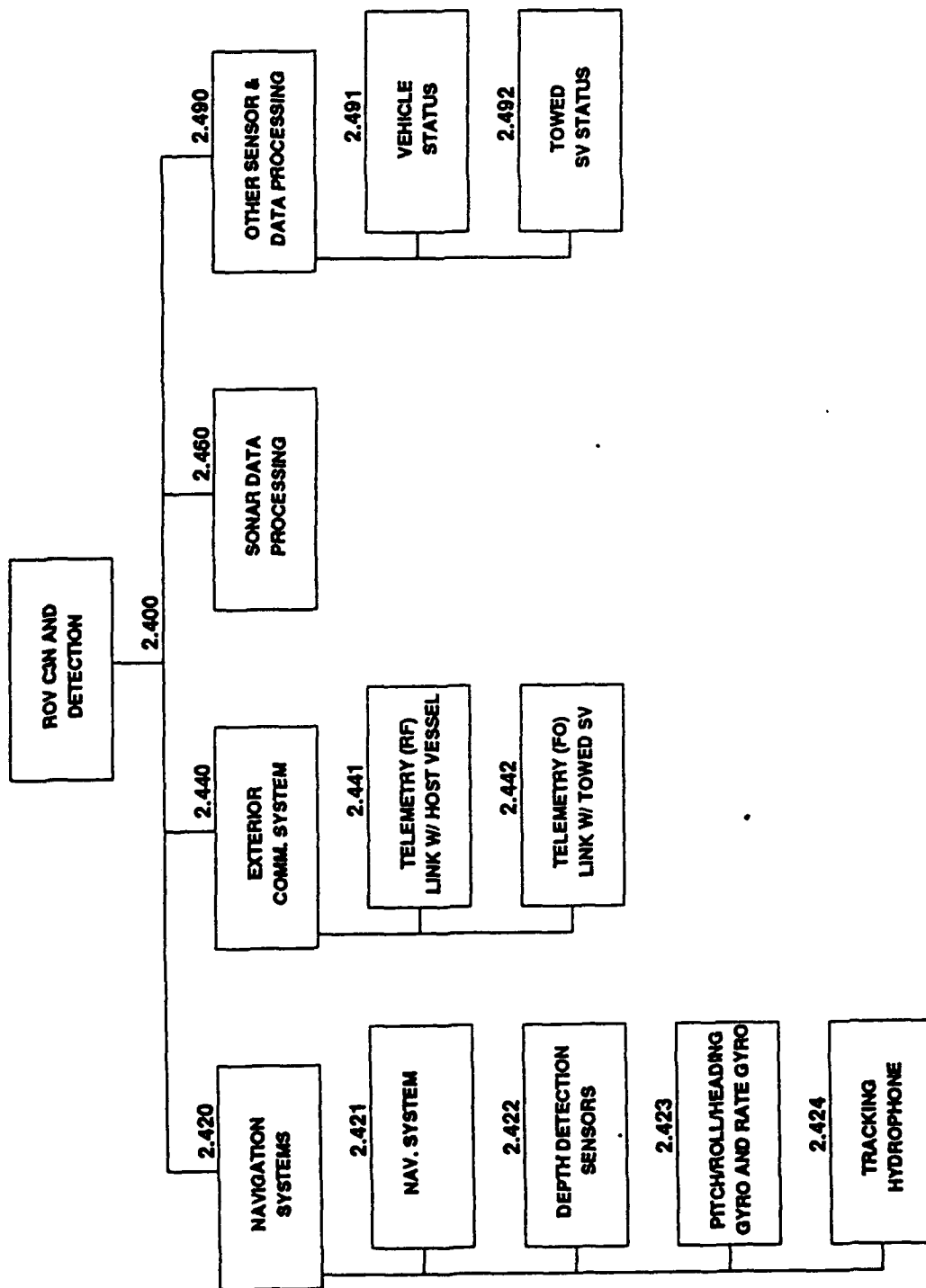
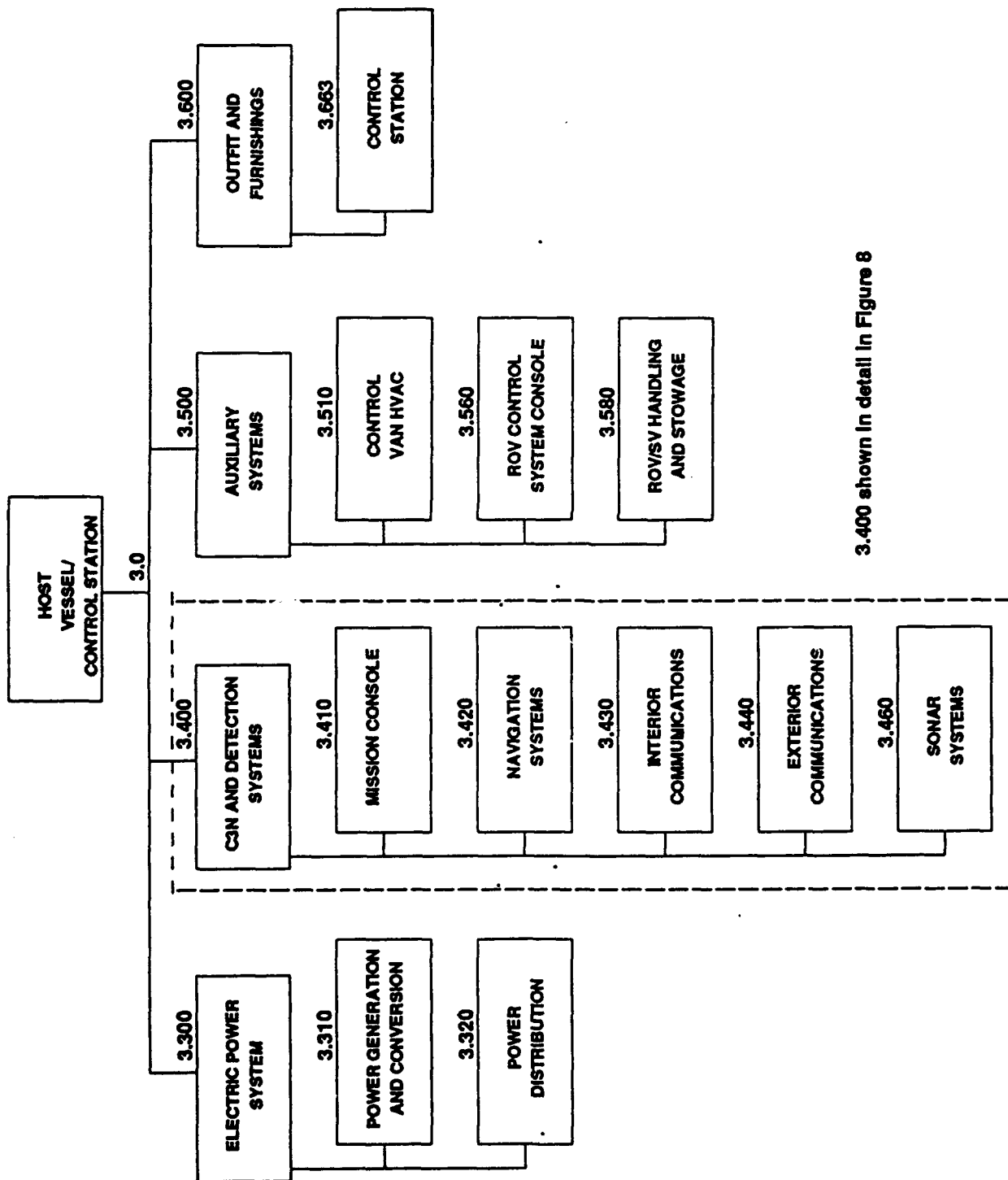


Figure 6. ROV C3N and Detection Risk Assessment WBS



3.400 shown in detail in Figure 8

Figure 7. Host Vessel/Control Station Risk Assessment WBS

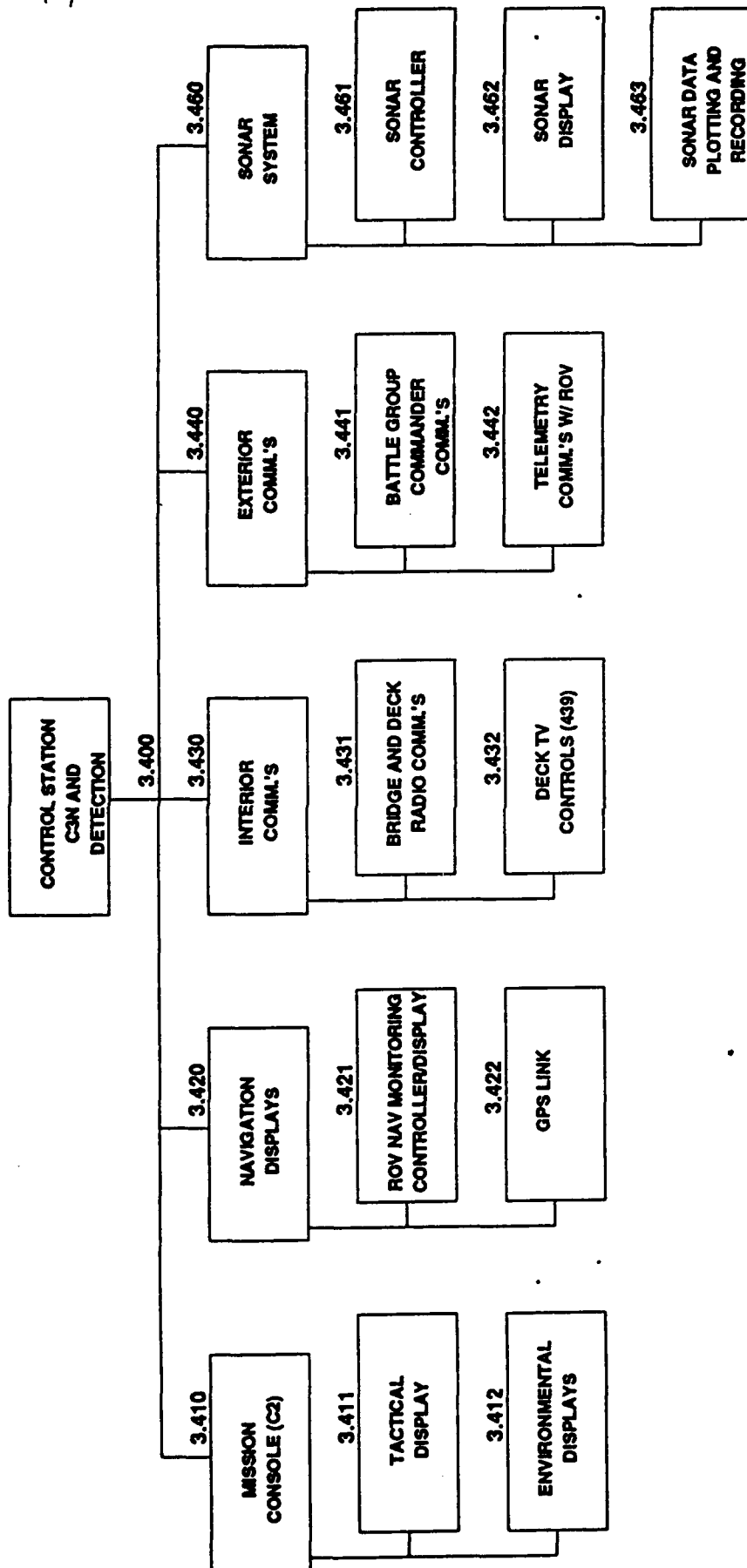


Figure 8. Control Station C3N and Detection Risk Assessment WBS